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MICROSCOPY

IN

MEDICAL PRACTICE:

ITS NECESSITY DEMONSTRATED IN THE INVESTIGATION OF DISEASE.

BY

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"Honor the Physician for the use you have of him."—SIRACHIDES.

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CORRECTIONS.

Page 5—sixth line from bottom: for "Jeiss" read *Zeiss.*

Page 9—thirteenth line from top: for "Glass" read *Class.*

Page 20—twenty-third line from top: for "pressure" read *presence.*

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Microscopy in Medical Practice.

The present diagnosticating of diseases, is based almost exclusively upon physical examination. The subjective symptoms do not guide the practitioner, but chiefly those which he can count, measure, weigh, hear, touch, smell, and above all, see.

For this purpose various instruments have been invented, in the last half-century, to aid the special organs of the practitioner in his diagnosis. As the thermometer tests the heat, so does the sphygmograph the pulse; the stethoscope, and now the microphone and telephone aid the hearing; the ophthalmoscope and laryngoscope, the sight. But neither of them has revealed as much to the medical practitioner as the microscope.

Until within a very few years, the scientific investigation of diseases, and the practical treatment and relief of the various maladies, to which humanity is subject, were held to be so entirely separated and distinct, that the medical practitioner was not expected to, nor did he, attempt to cultivate the knowledge of chemistry, materia medica, the therapeutic effects of drugs, histology, or microscopy. All these important and essential branches of the healing art, were looked upon as accessory, but by no means indispensable to the practice of medicine. The average practitioner, has seemingly contented himself with the temporary mitigation of the patient's sufferings, imagining that any time or talent spent in the investigation of its primary cause, was superfluous and unnecessary.

The developments of the last half-century, have shown most emphatically, that a practical and an intimate knowledge

of histology and microscropy, is as positively essential to the skillful and successful physician as an acquaintance with the principles of geometric and linear drawing would be to the architect or artist. Unless the medical attendant can diagnose the malady accurately, and trace the disease to its source, promptly watching, and even anticipating the chemical changes to which the human system in its abnormal condition is hourly subject, he cannot expect to be successful in his treatment, or to enjoy the confidence of his patients.

Even so early as the seventeenth and eighteenth centuries, the importance of histology and microscopy as auxiliaries to medical practice, began to be appreciated and acknowledged. The examination of the tissues, through the medium of crudely-made, but powerful magnifying lenses, is spoken of by Fallopius (1523-62). They were first introduced by Janssen (1590), an optician of Holland. The more minute structures of the human organism, were hidden from their gaze. They had neglected the marvels and mysteries of microscopic investigation, for the more elementary and comparatively simple branches of medical science, physiology, embryology, and comparative anatomy. Thus, with the exception of the work of Fontana, Muys, Lieberhuhn, Hewson and Prochasha, histology progressed but slowly during the whole of the seventeenth and eighteenth centuries, and its bibliography was little more than a disjointed collection of isolated observations. The first attempt to treat histology scientifically, and to award to microscopical investigation its proper position in medical practice, was made by M. Bichat, in 1801, when he published his far-famed *Anatomie Generale.* In this production he not only furnished a full and clear definition of the tissues, but gave perfect illustration of their physiological functions, and morbid alterations.

A few years afterward, (1809), Harting's achromatic microscope opened up a new and invaluable field of observation and research, and afforded an opportunity for the development of the law of cell-genesis and the molecular theory, so ably and satisfactorily systematized by Schwann and his successors, and brought to still greater perfection in the *Cellular*

Pathology of Virchow. The best, most popular, most comprehensive recent European work on general microscopy, is that of L. Dippel, (1867–69). Dr. Henry Frey's admirable work *The Microscope and the Microscopical Technic* as allied to the study of histology and clinical practice, is universally regarded by the medical and scientific world, as the highest and the most reliable authority on this important subject. It is translated into the English language by G. R. Cutter, M. D. The English work of L. Beale, *The Microscope in Medicine*, (4th edition, 1878), and the work of A. H. Hassall, *Illustrations of the Microscopic Anatomy of the Human Body in Health and Disease*, are to my mind an absolute necessity to the physician and student.

Microscopical investigation is so essentially a component part of histology, and of medicine generally, that the student cannot possibly study any one department of medical science without its aid as a sheet-anchor. Anatomy, physiology, pathology, chemistry, botany, toxicology and hygiene, are all more or less dependent for their demonstration and practical application to the human race on microscopic analysis.

While histology relates to the form and general doctrine of the elementary part of the human system, microscopical anatomy is concerned with the understanding of the microscopic forms, and with the laws of their structure and development, and their condition in health and disease. A collection of microscopical preparations is indispensably necessary for the exact study of histology, but it is a great mistake to suppose that *any microscope* will serve the purpose. The value of a microscope consists in its clearness of definition and objective power; many are in the market of inferior quality. Those made by Hartnack, of Potsdam; Smith, Beck, and Ross, of London; Spencer, of Wales; Dentmayer, and in particular, Tolles, of Boston, and Carl Jeiss, of Jena, have thus far exceeded them all by their constructions of the oil and homogenious immersion objectives, and being the most effective and reliable in my opinion.

Every practitioner and every student should not only possess a good microscope, but he should also know how to use it,

prepare his specimens for examination, and make accurate and careful drawings of his observations; for no amount of oral instructions or study, however good the teaching or text-book may be, will afford him that tangible or practical acquaintance with the microscopic character of objects, presented to his notice, which the personal preparation and examination of those objects would ensure.

It would be Impossible for me within the brief limits of this paper, to describe in detail, or even to enumerate the manifold uses of the microscope in the various departments of medicine and surgery. But in order that the physician of to-day may be enabled to keep pace with the demands of society, and the rapid studies which every other department of science has made;—in order that every practitioner of medicine may see the necessity of becoming his own microscopist, and appreciate its essential importance as the basis of his studies in pathology, physiology and therapeutics;—in order that he may avoid the errors, omissions and false conclusions into which our fathers in medicine have unwittingly fallen,—I will cursorily enumerate some of the uses and advantages attendant upon the introduction of microscopical investigation as a substantial and indispensable element in the practice of medicine.

Had Jenner known and understood the value of microscopy, he would not have outraged common sense and violated the first principies of nature, by the introduction of that insidious poison, vaccine, into the human system.

Had Harvey been thoroughly acquainted with the form and character of the blood-corpuscles, the changes to which they were subject, the method of enumerating them, and their importance as an element of diagnosis, his immortal discovery would have been immeasurably enhanced in value; thousands of lives might have been saved, or their lives prolonged; and the divine art of healing would have been brought to a far greater pitch of perfection than it yet has reached.

Neither in this country nor in England, despite the practical character of the people, has the public feeling been thoroughly awakened to the necessity of combining scientific investigation of disease with the treatment of the sick. As a natural

consequence, the amount of real knowledge concerning the origin, nature and properties of contagious poisons on the human organism, the morbific and chemical changes arising from the various abnormalities to which that organism is subject from atmospheric and other influences, and the influence exercised by constitutional or hereditary tendencies to disease is very scanty and fragmentary in its character.

Even the statistical information, periodically obtained by the local municipal organizations in the great cities on either side of the Atlantic, were, and still are, incomplete and unreliable, from the fact that they signally fail in tracing the several diseases to their origin, and therefore, leave the great underlying evil unremedied and obscure. Whereas, were only one-third of the generous contribution for the relief of the sick poor, in the shape of benefactions to hospitals, dispensaries, and diet-kitchens, set apart to the investigation of the primary cause of disease by the organization of a microscopical and pathological laboratory in connection with every public institution, the inmates would be saved from a vast amount of suffering; the rate of mortality would be materially lessened; the taxation of the community would be reduced to a minimum; and the scientific skill of the medical faculty, as a whole, would be raised to an elevation which would command and obtain the universal confidence, and esteem, of the community generally.

These considerations bring us to the great question of the methods by which microscopical investigation, may be made available to the requirements of the medical science at the present time; and how far it is an imperative necessity in the treatment of disease.

In the study of the elementary parts of the muscular system, its structure and mode of action, and the general arrangement of the nervous organism, the plan of its distribution and reflex action, and the nature of nerve-force, microscopical examination is the only practical medium by which we can arrive at a knowledge of the phenomena of nervous affections generally, or discover efficient methods of treatment.

Then again, in ascertaining the nature of contagious dis-

ease, or rather of the poison-germ from which it originated; how it passes from the infected to the sound organism; by what channels it enters the body; the exact changes it induces in the composition of the blood and the secondary alterations produced by it, in the various tissues and organs of the body; the points of difference, in the solids and fluids of the infected and healthy organism; the action of the poison from the period of its entrance, until the destruction of the life of the organism, and the morbid appearance after death—all these vital questions can alone be solved by careful, and detailed microscopical examination. Still further, in the pursuit of scientific inquiry into the causes and operation of exanthematous affections, special fevers of malarious and miasmatic origin, skin-diseases, and constitutional dyscrasiæ, such as syphilis, scrofula, rachitic affections, and other maladies, indicating hereditary taint.

Microscopical analysis alone, furnishes the key-note for accurate diagnosis, or efficacious treatment and ultimate eradication. Seeing, then, that every identical department of medical practice is dependent for its successful prosecution on the physician's ability for microscopical exploration, and his perfect understanding and utilization of the result arrived at—the idea which has found considerable favor, both in America and England, of separating the study of medical microscopy from the ordinary curriculum, and establishing a special microscopical department, in connection with the leading institutions, however perfect it may appear in theory, would, in fact, prove unpractical and abortive.

As a rule, every physician should be his own microscopist—each individual being left free to work in his own way, according to his views of the cases brought under his special notice. By this means, many valuable facts and ideas would be evolved, which would be impossible by systematic or associated effort. As accessory to, and in connection with diagnostication of the normal and abnormal conditions of the human system, there are other departments in which microscopical analysis and manipulation is absolutely necessary, and which it is essential that the physician should understand

—viz.: the character of the solids and fluids in the food and liquids—in the investigation of their purity or impurity—and the action of the elements of various substances and preparations on the human economy, for purposes of medical jurisprudence. We shall briefly refer to each of these points in due course. *First*, we will consider the *microscope and accessory apparatus.* The *compound microscope*, is the only one now used for microscopical research—that for ordinary medical purpose, varying in price from twenty to one hundred and fifty dollars. Dr. Oliver Wendell Holmes in an address before the Boston Microscopical Society stated, that the best microscopical work ever done, was that with a twenty-dollar microscope. The Clinical, Pocket, Travelling and Glass microscope, is especially designed for general observation in the fields, for use at the bedside or in the hospital, or for class-demonstration, and may be used for transparent objects, either in the ordinary daylight, or with the direct light of a lamp; and for opaque objects, ordinary reflected light of a small petroleum lamp, or even a wax candle placed a short distance from the aperture, just below or above the object for immediate examination, are sold from eighteen to twenty-five dollars. The pocket microscope which is a constant companion of mine, and which magnifies from sixty to one hundred and twenty diameters, made by Zeiss of Jena, cost the whole sum of five marks. In examining opaque preparations, a bull's eye condenser should be used.

For artificial illuminations, a small French moderator lamp, or a paraffine lamp with a round wick, will be found very useful, even where gas is available, and would only cost from forty to seventy-five cents. But the best of all is a common low petroleum lamp with a *Richmond burner* and wick, which can be attached to any hand-lamp. When gas can be judiciously employed, it is advisable to use an Argand burner. The instruments and apparatus for drawing and measuring objects, for photographing, for making dissections, cutting sections of tissues, chemical analysis and general purposes, and the necessary re-agents, I need not enumerate.

Tissues should be examined through a medium resembling

as nearly as possible, that which surrounds them during life both in density and fluidity—albumen and water, for instance. Highly-refracting structure requires immersion in a highly-refracting material, in order to convey an accurate idea of their arrangements; white fibrous tissue and morbid growths, for example, being easily discernible in ordinary syrup, glycerine, or strong solution of grape sugar, etc. The difficulty of distinguishing the structure of many organs and tissues, is extremely great; and considerable experience is required, before the student can clearly demonstrate the anatomical character of a healthy tissue. This difficulty is very much enhanced in the examination of morbid growth, from the liability there is, to mistake the change of character produced by the re-agent for a morbid alteration. It is especially desirable that the student should make frequent examinations of the structure of kidney and liver in man and in the lower animals, while in their normally healthy condition, because these organs are particularly susceptible of disease and undergo marked changes of structure.

Drawing and measuring.—Progress in our knowledge of minute structures, whether in healthy or diseased tissues, almost entirely depends upon the drawings made. The student or his teacher cannot possibly describe it orally so as to convey an accurate idea of the condition to his audience. Whatever is observed is worth copying, and microscopic texture must be portrayed faithfully or not at all. In many instances photography may be made available for reproduction of these textures. But there are many structures, the color of which alone would obviate the employment of that process. In drawing, the light should be carefully arranged, the object should not be too intensely illuminated, and the paper should not be too much in the shade. The distance between the reflector and the paper should be precisely the same, as from the object to the eye-piece, provided the distance is ten inches or 250 millimetres. When drawings are made with the aid of the camera lucida, a sun microscope, or condenser with Dr. Willis' heliostat, by which to throw a constant ray of light

upon one point, is very useful, and by aid of photography absolutely necessary and indispensable.

In measuring the diameter of objects, the magnifying power of every objective should first be ascertained, and a scale of measurements be adopted therefrom by which the dimensions of every object could at once be determined. In class-demonstration, the chief points of description are shape, edge, color, transparency, contents, size and effect of re-agents.

We do not need in this paper to enter into any description of the method of examining and preparing tissues, but would observe, *en passant*, that, as a general rule, chromic acid and bichromate of potassa, dissolved in glycerine instead of water, constitutes the basis of the solution for hardening tissues, in the German and English schools, and in some of the American institutions, although many others are recommended, according as the substance is soft or hard—viz.: acetic acid, picric acid, osmic acid, alcohol, etc. In order to assure the permanent preservation of tissues, they must first thoroughly be dried, and kept dry, or immersed in some resinous substance, or other medium which undergoes little or no change—some fluid medium miscible in water and aqueous fluids, but which has the property of preventing decomposition, and will not itself become decomposed. Upon the whole I am of the opinion, that the best glycerine and glycerine jelly are the most advantageous media for preserving animal tissues. Carbolic-acid water and kreosote fluids may be used for the preservation of various specimens, for which a fluid possessing the highly-refracting properties of glycerine is not suitable. Most tissues may be mounted in Canada balsam or gumdamar, without being previously dried, by the use of strong alcohol, and then oil of cloves or kreosote; and when once mounted, the specimen retains its character for years, and is probably as permanent as anything can be. There are, however, two important objections to the use of Canada balsam or damar. The most important anatomical peculiarities of most animal tissues, are entirely destroyed by the process. It is impossible to form any idea of the relative position of delicate structure lying one over the other. In

consequence of the contraction which has taken place, fibres which really lie above or below one another, appear in the mounted specimens upon precisely the same place; and delicate tissues of nerve-fibres, which, in most specimens, can be moved slightly over one another, and which are quite distinct and separate, appear in balsam-preparations to be fused together, forming one fibre, and seeming to run in perfectly straight lines. The other objection to mounting specimens in balsam, damar, and similar media, is that they are not susceptible of further dissection, while glycerine specimens can be removed after they have been mounted for years, and divided into several portions, dissected and remounted.

Casts for microscopic specimens.—By making casts for microscopic specimens, facts may sometimes be ascertained which cannot be demonstrated by examining the specimens themselves. There are irregularities of surface in the case of many delicate tissues that may be rendered very evident by making a cast in gelatine, varnish or collodion, in either of which casts of the most delicate structure may be obtained. As it takes the most minute workings of the original to which it is applied, the microscopic structure of the original is faithfully reproduced in the cast. By this same process, substances as adhering to the surface of natural objects may be removed, and the surface thus freed from foreign bodies. The latter if so desired may be separately examined. Microscopic hair-like appendages of the surface may be attached to the film, and withdrawn with it from the tissue in which they were growing. We may in this way prove whether certain appearances indicative of tissue, such as nerve-fibres projecting free from a general surface, result from actual structure or are due to some optical effect.

Injection of tissues for microscopical examinations.—In both healthy and morbid structures, many points of great importance can alone be made out, from the examination of injected preparations. From their extreme tensity and perfect transparency, the capillary vessels are scarcely

distinguishable. If we examine uninjected preparations only, we may conclude that a tissue is only slightly vascular, when, in fact it is abundantly supplied with vessels. In other cases, a tissue which is almost entirely composed of a network of capillaries, may be erroneously described as a fibrous matrix or supporting framework. *Capillary vessels* when uninjected, usually collapse, and in the course of microscopical preparation, may be pressed and somewhat torn and stretched, and therefore easily mistaken for nerve-fibres, or fibrous or connective tissue. Morbid growths, especially, should be injected prior to microscopical examination, as great confusion and fatal error have frequently resulted from the arrangement of those vessels being mistaken or overlooked. It is hardly to be expected that we shall be able to ascertain the nature of the texture, or the history of the various stages through which a particular structure has passed in the course of growth, unless the arrangement of the vessels has been accurately made out, and their precise relation to the most important anatomical elements of the tissue accurately demonstrated.

Transparent injecting fluids alone answer the purpose of microscopical investigation, especially for making minute injections of the arteries, capillaries, as well as lymphatics and the ducts of glands. This fluid consists of Prussian blue, which is generally used for injection into the veins and capillaries in a state of very minute division, suspended in a solution, which acts the part of preserving fluid. The particles of blue are quite insoluble, so that they will not press through the basement-membrane, but at the same time they are so minute, that, when examined by high power, the precipitate appears uniform and homogeneous. It runs very freely, and a perfect injection of it can be made with it in the course of a few minutes. Aniline blue and indigo carmine, are also used and highly recommended for lymphatic glands, spleen, brain and spinal marrow preparations.

Carmine and vermilion are generally used for the arteries and yellow in the lympathics with Harting's mass, (chromic potash solution), while still another shade of color can

be used in the gland-ducts. But none of either is better adapted and of greater importance to practitioners, who have little time at their disposal for much work, than the Prussian blue. It is well adapted for injecting morbid growths, and it possesses many advantages over injecting fluids. It can be kept for a length of time without being impaired, and can be used at once. No warming is necessary before injecting the tissue, as in the case of the size-preparations, and the preparation may be examined immediately after the injection is completed. The fluid is inexpensive. It tends to harden the coats of the vessels as it passes through their channels, while at the same time it increases the transparency of the specimen The color is not effected by acids; and after having been removed by alkalies, it may be immediately restored, upon the addition of an acid. Capillaries thus injected may be examined by the highest objectives. The same remarks will generally apply to morbid growths.

Staining of tissues, cells and bioplasm.—The many artificial processes proposed for the purpose of rendering a transparent and perhaps invisible substance more or less distinct, the staining process is most efficient. Many points of great interest may be made out in the structural arrangements of the tissues, and by this process alone, the germinal or living matter, or bioplasm concerned in tissue-production, can be accurately demonstrated and distinguished from less important constituents of the tissues.

Comparatively few of the bioplasts or masses of living matter (as nuclei of tissue) are demonstrated by those observers who simply examine textures in water, serum, vitreous humor, etc. The object of employing this method is to bring out the bioplasm, or living or germinal matter of the cell or texture, and the peculiarities of the formed material cell-wall, intercellular substance or tissue. For this purpose many ingredients have been recommended, as carmine, aniline hæmatoxyline, eosin, osmium acid, nitrate of silver, and many others; and for the last few years, the double-staining process has received the general favor. The following has

proved in my hands the most successful, and served all indications. A combination of one part of eosin to sixty parts of methyl green, dissolved in warm alcohol. If preparations are stained with this, which only requires twenty minutes, the epithelial cells are colored red, violet, or blue; the cells of the connective tissues, green to blue-green; while the nucleolus will be colored red. Cuticular structures always become dark green; lymphatic cells, blue; blue-green striped muscular fibre where red, but its nuclei, green; while the smooth muscular fibre became green and its intercellular substance red. You will observe how important such combinations are. Preparations thus treated are especially useful in the lecture-rooms, shown with the *hydro-oxygen microscope.* He is the best practitioner who is always using his best endeavors to form an accurate conception of the changes which are going on in the tissues and organs while the patient is still alive and in health, and accustoms himself to the contemplation of how those changes are disturbed, modified, or arrested by disease. All our minute investigations upon tissues after death, should be conducted with this object in view. The anatomical analysis should be carried out in the hope that the facts may be synthetically combined, and thus a mental image be formed in which the actual phenomena of life are presented to the mind and, as it were, seen in the perfection of their activity. The minute anatomy of healthy and morbid structures constitutes, indeed, the foundation upon which physiological and pathological knowledge in a great measure rest. The facts of minute anatomy are, as it were, the dry bones which have to be afterward clothed with active motor organs. The facts now learned in the dissecting-room and in the dead-house, when contemplated by the trained and well-stored mind of the thoughtful physician, are made to live. No work can be more worthy, and will be more to the advantage of mankind when more of the most gifted intellects are engaged in it.

Some idea of the progress that has been made, both in observation and philosophical generalization, may be formed by comparing the information we possess concerning the actual phenomena of growth, irritation and inflammation,

with the absurd ideas prevalent less than a quarter of a century since. We may feel sure that by further investigation we shall be able to realize more fully the actual changes proceeding in internal tissues and organs, although it may never be possible to submit these to actual examination during life. We may be prevented from obtaining anything but indirect knowledge, but nevertheless the conclusion will, in some instances, be found to be not less reliable than others which are based upon practical observation.

THE MICROSCOPICAL EXAMINATION OF LIVING THINGS.—Some living things may be examined under the microscope without much difficulty. Many of the lower animals and certain vegetable tissues require only to be placed upon the glass slide, in a drop of water in which they live, and to be covered with thin glass, care being taken to prevent undue pressure. No cement, balsam or varnish need be used, but free access of air to the edges of the fluids must be permitted. In cases in which prolonged observations are required, arrangements must be made to compensate for the loss of fluid by evaporation which would occur, under ordinary circumstances, the proper degree of temperature to sustain life, of feeding the living matter, and the application of chemical re-agents to them under the microscope. The movements occurring in living bodies which can be distinctly observed through the microscope, are *primary* or *vital* movements as in blood, mucus and pus; the *secondary* movements, indirectly occasioned by vital phenomena, but affecting dead matter, such as ciliary and muscular action; and *inorganic* movements, not depending upon vital phenomena, but occurring equally in living and non-living matter, such as molecular movements, and movements of solid particles suspended in fluid, caused by the currents therein. By the aid of the microscope we are enabled to distinguish many substances with certainty, but amorphous particles are very often met with, the nature of which it is impossible to ascertain, by microscopic investigation only. It is therefore necessary to study the effect of certain re-agents upon the substances under the

microscope. We may learn by microscopical examination that a texture is granular, fibrous, opaque, more or less transparent, etc.; but nothing of its physical and chemical properties can be ascertained by simply looking at it. The same appearances are manifested by several different substances. It is necessary, therefore, to resort to a chemical examination to determine the nature of many things which come under examination. If, however, the composition of any body having well-defined microscopical characters has been once conclusively determined, we shall be enabled afterward to recognize it, by resorting to microscopical examination. Every specimen of granular matter requires chemical analysis, which may be conducted while it remains upon the glass slide; and the reactions induced may be studied nnder the microscope. In almost every branch of microscopical enquiry, the greatest assistance is derived from the use of chemical re-agents. Knowledge of the behavior of certain substances with particular chemical re-agents, and the application of this information to microscopical investigation, often enables us to distinguish peculiarities of structure, to ascertain the chemical composition of minute quantities of matter, and to demonstrate clearly the existence of particular compounds in the animal frame with the greatest certainty. Some of these probably would entirely escape our observations if we subjected them separately to the most careful chemical analysis, or the most searching microscopical examination.

The application of chemical analysis to microscopical investigation, has thrown a new light upon the nature of many physiological changes which are constantly taking place in the organized bodies in health, and enable us to investigate satisfactorily the modifications, occurring when these processes are subjected to the influence of conditions which counteract healthy action. Such matters are of the deepest interest to us, as practitioners of medicine. In the various forms of disease which are constantly being brought before us, we ought to study as minutely as possible, the nature and course of morbid actions, which it is our duty to investigate fully. By scientific research, we may be led to suggest means to modify

or counteract morbid action, and may, perhaps, even be able to prevent their occurrence. The laboratory is a very necessary adjunct to the dissecting-room, the museum, the post-mortem room, and the clinical wards of our hospitals. Whoever desires to employ all the means at present at our disposal for unravelling the mysteries of disease, in order to form a correct diagnosis, or to ascertain the right course of treatment, will do well to make this particular branch of chemistry, in conjunction with microscopical examination, an essential part of this study.

The re-agents required for chemico-microscopical examination are not very numerous. They should be perfectly pure. Of the greater number, only a very small quantity is required; but of alcohol, ether and one or two other re-agents, it is necessary to have half a pint or more.

SPECTRUM MICROSCOPIC ANALYSIS.—Of all the methods for detecting chemical substances in a solid, liquid or gaseous state, that with the aid of the stereoscope is the most delicate. Sir David Brewster claims to have been the first to have employed spectrum-analysis, but the process was first brought to perfection by Brunsen and Kirchoff of Heidelberg by whose wonderful discoveries an entirely new field of research has been opened. Improvements in the method of observation have since been made, by a great number of observers, and the spectroscope has now become a valuable and indispensable instrument of chemical research. This method of analysis has been recently applied by Sorby to the microscope. Already many important steps have been gained, and it is probable that much will be discovered by this new method of inquiry. The chief use of the spectrum microscope, is that it enables us to determine with ease and certainty, and in a very short space of time, the nature of many organic substances of very complex composition, for a great number of which no other means of detection and demonstration are known. The application of the spectrum-microscope to physiological questions, will doubtless lead to a number of important conclusions. Much remains to be learned, and what has been done

so far, merely serves to show what may be expected. Hitherto the coloring matters of the blood and bile have attracted the most attention, but those found in urine and fæces are equally deserving of careful study; and when we come to comparative physiology, those formed in eggs, hair, feathers, scales, or other tissues open out an extremely wide field for investigation, and have even already yielded remarkable facts. In jaundice, and probably in some other disease, the yellow substance in fæces, which rapidly passes into an orange-colored substance by exposure to the air, is not excreted in the normal manner, but occurs in large quantities in the urine in the oxidized state, and can be easily recognized by means of the well-marked absorption-band seen in the blue and of the green part of the spectrum. It is probably a product derived from bile, by some change not yet fully understood. No accurate description of anatomical or physiological changes, no clear account of the phenomena of living, healthy and morbid textures, can be given until the term used has been clearly defined. Want of attention to this point has not only occasioned great perplexity, but has led to such confused ideas that we can scarcely hope that anything like a clear account of some of the simplest morbid changes, will be given in our text-books for many years to come.

In many departments the student will not only be misled by dogmatic assertions, but he will find that these very authorities have been misled. They are often instrumental in misleading other authorities where there exists a kind of mutual generosity of feeling and a disposition not to be too hard upon each other, in order that a measure of credit and public confidence may be enjoyed by each.

Until it is generally understood that persons regarded as authorities must define what they mean by the terms they use, confusion of ideas must necessarily prevail on many things that would otherwise be perfectly clear. If an observer is in doubt whether the character of the object is truly conveyed by the words and phrases he selects, they should give expression to that doubt, or explain the sense in which the word is employed. It would be still better to illustrate their comments by drawings, which would invariably be appended.

There is scarcely an ailment to which humanity is liable, in which a critical microscopical examination of the blood, urine, sputa, vaginal secretions, pus, or contents of the stomach, is not absolutely necessary to an accurate diagnosis and consequent efficacious treatment. Even the remedies adopted, and their tonic, alterative, or diuretic action, and the chemical changes which they produce on the solids and fluids of the body, can be determined to a certainty and thoroughly understood through the medium of microscopical analysis.

In this important and extremely difficult matter of differentiating between the results of the primary infection or poison, such as syphilis, malarial, vegetable, animal or other poison, and the condition of the blood directly traceable to the administration of mercury, potassium, etc.—the science of medical microscopy has already worked miracles. Experience has proved beyond all possibility of dispute, that these differential analyses in order to be reliable, conclusive and clear, can only be conducted on the basis of microscopical revelations; a striking illustration of this fact being furnished in the cutaneous eruptions, affections of the bony structure, and constitutional changes in the solids, fluids, and tissues of the syphilitic patient, whose condition is the result of a three-fold influence—viz.: the pressure of the syphilitic poison in the blood, the chemical changes consequent on the abnormal conditions, and the action of mercury or other remedies administered. *The simple reason why the syphilitic poison is so seldom entirely eradicated from the human system*, is that the medical practitioner, either from indifference, inexperience, or neglect to institute a thorough microscopical investigation, has made an imperfect or incorrect diagnosis, and consequently failed in reaching the seat of the disease, or correcting the existing abnormal conditions.

In concluding this part of our subject, we would remark most emphatically that medical practitioners cannot expect to achieve any special eminence or skill in the practice of medicine, until, as in the medical schools of Germany, it is made an inflexible rule that no graduate shall be permitted to receive his diploma, unless he passes a thorough and successful

examination in microscopy. Until medical microscopy shall take its place side by side with anatomy and physiology, and is carried entirely through the curriculum of study, from matriculation to graduation, the physician will not be worthy of his high and holy calling, or merit the honorable title which his diploma has conferred upon him.

I feel that I would inflict a very great injustice upon you, and on the important subject which has engaged our attention, if I did not briefly review the position of the microscope as an agent in medico-legal investigations. For the last two centuries, at any rate, prior to the introduction of the microscope as a scientific detective, medico-legal jurisprudence was little better than a lottery. The longest tongue and the largest purse, regardless of right, almost invariably won the day.

The operations of the compound and spectrum microscope, are rapidly terminating the noisy disputations, and dispersing the fanciful theories of the experts who, for so many generations, have bewildered the juries, and perplexed the judges by their conflicting statements and opinion. The poisoner and the assassin are no longer sustained and protected by the difference of professional opinion. Through the medium of that silent; but measuring witness, the microscope, the dawning evidence of the human blood-stain on the criminal's clothing, the sputa or dejecta of the victim, or the analysis of the secretions, or contents of the stomach, fixes the crime on the perpetrator. On the other hand, it is an equally effective agent in proclaiming the innocence of the victim of circumstantial evidence, by tracing to natural or accidental causes those appearances and occurrences from which suspicion first arose. Much has been, and still more is expected to be discovered through the medium of the microscope.

The Germ-theory, Embryology and Darwinism owe their existence and progress to the microscope. So long, however, as there exists a diversity of opinion among the different authorities, and all do not see the same object or subject in the same light, and under the same circumstances; and so long as one authority completely ignores what another has demonstrated, we can never expect that our efforts will be crowned

with success and the science come to perfection. But within the last few years, remarkable progress has been made in all branches, which we have hitherto related, in Europe as well as in this country, day by day new accessories are invented to aid the microscopist in his researches. Microscopical journals are publishing the progress which is made, and even some medical journals devote a space in their pages to microscopy. Microscopical societies have, also, been organized in almost every large city, quite as successful as those in England; and at this present moment, there is a call for the purpose of organizing A MEDICAL POSTAL MICROSCOPICAL SOCIETY, the intention of which shall be to exchange specimens through the mail, from one member to the other, whereby every facility is offered to the practitioner to acquaint himself with the work and views of the different observers. Any medical practitioner who works with the microscope can apply for membership by addressing to John Phin, 14 Dey Street, New York.

And now, gentlemen, I think you will fully coincide with me in claiming for the microscope, a pre-eminent position in medical practice as the only reliable foundation for accurate diagnosis and successful treatment; as the only basis on which the analysist, the anatomist, the physiologist, the toxicologist, or the surgeon, can found his observations and arrive at any practical course of treatment; as the unfailing arbitrator in all medico-legal disputes, and as the great pacificator in all conflicts of professional experience or skill. The great fact of the future, to which we as medical practitioners, the scientific world generally, and the community as a whole, look forward —and which I humbly predict will be accomplished before this present century closes upon us—is to find every physician his own microscopist.

322 Shawmut Avenue,

Boston, Mass., June, 1880.

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